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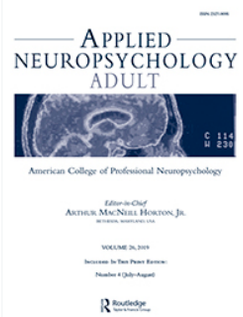

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Neuropsychological assessment of adults with ADHD: A Delphi consensus study

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ABSTRACT

Within the clinical evaluation of adults with attention deficit hyperactivity disorder (ADHD), cognitive functions are often assessed to characterize individual cognitive problems and guide treatment planning. However, the composition of an adequate neuropsychological assessment battery remains difficult given the large number of cognitive functions that can be distinguished, the variety of available tools to assess these functions, as well as the cognitive heterogeneity that has been observed between individuals with ADHD. Twenty-seven clinicians and researchers experienced in working with adults with ADHD took part in the present study. This study employed the Delphi methodology in order to compose an assessment battery for the measurement of the most important neuropsychological functions by employing the most suitable measures to assess these functions. Consensus between experts was achieved on a ranking of 16 neuropsychological functions that are important for the neuropsychological assessment of adults with ADHD. Furthermore, measures were suggested to assess each of the neuropsychological functions. The assessment battery as composed in the present study may support research and clinical practice in the selection of appropriate functions and measures for the determination of the individual level of cognitive functioning and treatment planning of adults with ADHD.

KEYWORDS

Adult ADHD; cognition; Delphi; neuropsychological assessment

It is estimated that about 30–60% of children diagnosed with attention deficit hyperactivity disorder (ADHD) still suffer from symptoms of ADHD in adulthood (American Psychiatric Association, 2013; Barbaresi et al., 2013; Biederman, Mick, & Faraone, 2000; Mannuzza et al., 1991; Seidman, Valera, & Makris, 2005). The prevalence of adult ADHD is estimated to be around 3.4% worldwide (Fayyad et al., 2007), representing one of the most common psychiatric conditions in adulthood (American Psychiatric Association, 2013). One of the common features of ADHD are pronounced impairments in multiple aspects of cognition (Barkley, Murphy, & Fischer, 2007; Kooij et al., 2010). These cognitive impairments were shown to be associated with functional impairments in various domains, such as social functioning, academic achievement, occupational attainment, self-concept, as well as general well-being and quality of life (Agarwal, Goldenberg, Perry, & IsHak, 2012; Canu & Carlson, 2007; Diamantopoulou, Rydell, Thorell, & Bohlin, 2007; Fergusson, Lynskey, & Horwood, 1997; Kok, Groen, Fuermaier, & Tucha, 2016; Kooij et al., 2010).

Given the prominent role of cognitive impairments in adult ADHD, the clinical evaluation of adults with ADHD often comprise a neuropsychological assessment (Fuermaier et al., 2015; Hervey, Epstein, & Curry, 2004; Schoechlin & Engel, 2005; Seidman, 2006; Woods, Lovejoy, & Ball, 2002). Standardized neuropsychological assessment using psychometric test measures revealed significant group differences between adults with ADHD and healthy individuals in selective attention (L. Tucha et al., 2008), divided attention (Woods et al., 2002), as well as sustained attention/vigilance (Epstein, Johnson, Varia, & Conners, 2001; L. Tucha et al., 2017). Furthermore, adult ADHD has been associated with impairments in several aspects of executive control, such as working memory (Alderson, Kasper, Hudec, & Patros, 2013; Rohlf et al., 2012), planning and problem solving (L. Tucha et al., 2011), cognitive flexibility (Halleland, Haavik, & Lundervold, 2012), inhibition and impulse

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control (Boonstra, Oosterlaan, Sergeant, & Buitelaar, 2005; Boonstra, Kooij, Oosterlaan, Sergeant, & Buitelaar, 2010), risky behavior (Groen, Gaastra, Lewis-Evans, & Tucha, 2013), time perception (Barkley, Murphy, & Bush, 2001), concept formation (Antshel et al., 2010) as well as verbal and design fluency (Boonstra et al., 2005; O. Tucha et al., 2005; L. Tucha et al., 2011). Meta-analyses revealed that inhibition, working memory, cognitive flexibility and fluency tasks were most robustly impaired in adults with ADHD with effect sizes reaching moderate size (Alderson et al., 2013; Boonstra et al., 2005; Hervey et al., 2004; Schoechlin & Engel, 2005). Furthermore, neuropsychological research on adults with ADHD also demonstrated small to medium impairments in several aspects of learning and memory (Fuermaier et al., 2016; Kaplan, Dewey, Crawford, & Fisher, 1998; Muir-Broaddus, Rosenstein, Medina, & Soderberg, 2002; Pollak, Kahana-Vax, & Hoofien, 2008; Seidman, 2006). Deficits occur particularly in those memory functions that strongly rely on intact executive control, which suggests an involvement of executive dysfunctions in disturbed memory functioning of adults with ADHD (Altgassen, Kretschmer, & Kliegel, 2014; Fuermaier, Tucha, Koerts, Aschenbrenner, Weisbrod, et al., 2013; Fuermaier, Tucha, Koerts, Aschenbrenner, Westermann, et al., 2013; Pollak et al., 2008; White & Marks, 2004).

Despite the clear evidence of neuropsychological impairment in adults with ADHD, the selection of neuropsychological functions and appropriate assessment tools in a given assessment situation often remains difficult due to several reasons. First, as presented above, neuropsychological impairments in adults with ADHD have been shown in multiple aspects of cognition. A complete assessment of all neuropsychological functions discussed is presumably not possible as such an assessment may considerably exceed the time constraints of any assessment situation. Second, neuropsychologists have numerous tests to choose from in composing an assessment battery. No clear agreement has been established yet on which tools are considered most sensitive and appropriate for the neuropsychological assessment of adults with ADHD. For example, a review of Seidman (2006) identified more than 70 tests that had been used to compare adults with ADHD with healthy individuals. However, the sensitivity of these tests cannot be determined as the majority of tests were used in one or two studies only. Third, while adult ADHD is clearly associated with cognitive impairment as indicated in group studies, not all patients show deficits on all neuropsychological tests applied (Mostert et al., 2015; Seidman, 2006; Thome et al., 2012). In this context, it has been noted that individuals with ADHD have unique profiles of neuropsychological functioning, with some patients showing impairments in one function while other patients displaying impairments in another function (Thome et al., 2012).

In order to address the heterogeneity of approaches as currently used for the neuropsychological assessment of adults with ADHD, the present study aims to achieve consensus among an international panel of experts from the field of adult ADHD by means of the Delphi methodology. The Delphi methodology is a structured communication technique, which can facilitate collective decision making in a structured and anonymous way (for a review, see Boulkedid, Abdoul, Loustau, Sibony, & Alberti (2011)). The panel of experts of a Delphi study is requested to complete a series of questionnaires (so called 'rounds') interspersed with controlled feedback of the previous rounds at the beginning of each round (Dalkey & Helmer, 1963). The use of a Delphi method is of particular use when empirical studies on a certain question or issue are scarce or have not come to an agreement yet (Ziglio, 1996). A serial presentation of questionnaires, together with the presentation of group results of the previous round at the beginning of each round, allows the experts to modify their opinions with the aim of reaching group consensus (Sobaih, Ritchie, & Jones, 2012). Another strength of the Delphi method is that participation of the panel members is anonymous, which reduces group and/or peer pressure (Powell, 2003; Sobaih et al., 2012). As such, the influence of authority (e.g., based on the individual's personality, age and status) on the consensus is minimized. In the present study, the Delphi method is used to achieve consensus on how to compose a neuropsychological assessment battery of adults with ADHD by identifying the most relevant neuropsychological functions as well as the most suitable measures to assess these functions. Such an assessment battery could be useful for a precise description of the cognitive problems in individual patients with ADHD and to guide further treatment planning. The relevance of this assessment battery for research and clinical practice will be discussed.

Method

Delphi methodology

The present study employed the Delphi method with the aim to collect and converge the opinions of experts in the field of adult ADHD. The principles of this method are based on the notion of collective wisdom in decision-making, assuming that the combined opinion of several people converges closer to the truth than the opinion of one individual (Habibi, Sarafrazi, & Izadyar, 2014). The Delphi method is designed in a way to minimize

or eliminate the problems related to collective decision making in groups, such as (1) the influence of dominant or high-status members on other group members, (2) the group pressure to conform due to lack of anonymity, and (3) the necessity to be in one geographic location at the same time (Boulkedid et al., 2011; Dalkey & Helmer, 1963). This is achieved by a structured aggregation of independent, anonymous opinions of members of an expert panel by means of online questionnaires (Powell, 2003; Sobaih et al., 2012). The expert panel is requested to complete a series of questionnaires (in so-called rounds) interspersed with controlled feedback (Dalkey & Helmer, 1963). Feedback is given by the presentation of group results of the previous round at the beginning of each round, which encourages the expert panel to reconsider their previous responses and facilitates a conversion of opinions towards a consensus.

In the present study, we used a four-round modified Delphi method to collect the opinions of an expert panel regarding the neuropsychological assessment of adults with ADHD (see Table 1 for an overview of the rounds). The design of the Delphi method was modified in such a way that the first round started with a list of neuropsychological functions that were to be rated according to their relevance for a neuropsychological assessment of adults with ADHD, instead of open-ended questions as is traditionally done in Delphi studies (Hsu & Sandford, 2007). The Delphi rounds were consecutively conducted over the course of eleven months, whereas the collection of data of each of the four rounds took about four weeks. Questionnaires of each round were created and distributed by the use of the online research software Qualtrics (Qualtrics, 2016). Correspondence was conducted via e-mail and the responses to the Delphi rounds were confidential (by following a link as provided by email) in order to facilitate honest and unbiased responses. The expert panel was asked to complete the questionnaire of each round within four weeks. During this period, three reminders were sent to those panel members who did not respond yet. After two weeks of the initial invitation to the Delphi round, the first reminder was sent. Two additional reminders in intervals of one week were sent to inform panel member about the termination date of the particular round. Ethical approval for this study was obtained from the Ethical Committee Psychology affiliated to the University of Groningen, the Netherlands.

Participants and recruitment

The recruitment of suitable panel members with high expertise on the topic is considered as one of the most important determinants of success when conducting a Delphi study (Hsu & Sandford, 2007). Inclusion criteria of potential panel members were willingness to take part in the study as well as at least two scientific publications (peer-reviewed) about neuropsychological functioning of adults with ADHD. Candidates were identified based on publications as determined via scientific databases PsycInfo and PubMed. Moreover, clinical centers with specialized care for adults with ADHD were approached in order to identify suitable candidates.

Potential panel members were informed about the purpose of the study and were encouraged to recommend additional candidates with expertise in the field of adult ADHD. A total of 64 candidates opened the questionnaire and started to fill in responses to the questions of the first round. Twenty-seven of these 64 candidates actually completed the questionnaire. Only these 27 panel members were invited to the subsequent rounds. Twenty panel members completed the second round of the Delphi study, and 22 panel members completed the third round. Finally, in the fourth and last round, 21 panel members took part and completed the questionnaire.

Demographic characteristics of the panel members are presented in Table 2. The average age of the initial

Table 1. Overview of the Delphi rounds "Neuropsychological assessment of adults with ADHD".

Round 1	• Panel members rate the importance of each of the neuropsychological functions of a predetermined list. • Panel members suggest additional neuropsychological functions. • Panel members suggest measures for the assessment of those neuropsychological functions that they rated as important or very important.
Round 2	• Panel members rate the importance of all functions that were additionally suggested in Round 1. • Panel members suggest measures for the assessment of those functions that they rated as *important* or *very important*.
Round 3	• Panel members reconsider their ratings of neuropsychological functions of Rounds 1 and 2 in the light of the average ratings of all panel members. • Panel members rate the suitability of measures that were suggested in the previous rounds and that were on average rated as *important* or *very important*.
Round 4	• A ranking of all neuropsychological functions of the previous rounds is presented. • An assessment battery is presented to assess those neuropsychological functions that were on average rated as *important* or *very important*. • Panel members indicate agreement or disagreement with the assessment battery. • In case of disagreement, panel members indicate changes that would make them agree with the assessment battery.

Table 2. Characteristics of the expert panel.

	Round 1	Round 2	Round 3	Round 4
N	27	20	22	21
Age (in years, $M \pm SD$)	45.9 ± 10.4	45 ± 9.7	47.4 ± 10.5	45.8 ± 10.2
Gender (female/male)	10/17	10/10	10/12	10/11
Geographic location[a]	9/8/3/2/2/1/1/1	6/7/1/2/1/1/1/1	8/6/2/2/1/1/1/1	6/8/2/2/1/1/0/1
Academic background (psychology/medicine)	22/5	18/2	18/4	17/4
Academic degree/position (Prof/PhD/MSc)	7/16/4	4/13/3	5/14/3	4/12/5
Work (in %, clinic/research/other[b])	39/43/18	42/40/18	38/43/19	40/43/17
Number of publications related to adult ADHD ($M \pm SD$)	20.9 ± 43.1	8.9 ± 7.0	22.6 ± 47.0	23.7 ± 48.0

Note. [a]USA/Germany/UK/Netherlands/Norway/Turkey/Canada/Argentina. [b]other responsibilities entail teaching, administration, managing, mentoring, or a combination of those.

27 panel members was 45.9 years with a standard deviation of 10.4 years. Seventeen of the panel members were male and ten were female. Nine panel members currently worked in the United States, eight in Germany, three in the United Kingdom, two in the Netherlands, two in Norway, and one each in Turkey, Canada and Argentina. The panel members indicated various academic backgrounds, including psychology, clinical psychology, neuropsychology, developmental/school neuropsychology, neuroscience or medicine. Seven panel members held a full professorship, five panel members indicated to be associate professor, two panel members worked currently as assistant professor, nine additional panel members hold a doctor title (i.e., PhD), and four panel members had a degree as a master of science (i.e., MSc). The expert panel indicated to have in average 20.9 (SD = 43.1) scientific publications related to neuropsychological functioning of adults with ADHD. On average, panel members spent 39% (SD = 31%) of their working time on clinical work, 43% (SD = 28%) on research and 18% (SD = 24%) on other responsibilities. Other responsibilities entail either teaching, administration, managing, mentoring or a combination of those.

Materials and procedure

Round 1

The first round of the Delphi study had two aims, that is (1) to identify the most relevant neuropsychological functions that should be considered in a neuropsychological assessment of adults with ADHD, and (2) to collect suggestions for the measurement of these functions. Before the start of the first round, participants were requested to give informed consent and to respond to questions regarding demographic information.

In the beginning of the first round, the expert panel was presented with a list of 42 predetermined neuropsychological functions. This list of neuropsychological functions was created by means of a literature review that resulted in a total of 42 neuropsychological functions that were assigned to one of six categories, i.e., attention, executive functions, memory, perceptual functions, visuospatial functions and language functions. Panel members were asked to rate the relevance of each of the presented functions for the neuropsychological assessment of adults with ADHD on a 5-point Likert scale, i.e., 1 (*very important*), 2 (*important*), 3 (*neutral*), 4 (*not important*), to 5 (*not important at all*) (Table 3). Furthermore, panel members were given the possibility to add neuropsychological functions that should be additionally considered in a neuropsychological assessment of adults with ADHD. The relevance of the additional neuropsychological functions was rated on the same Likert scale as the functions presented before. After rating the relevance of all neuropsychological functions, the panel members were asked to indicate suitable measures to assess the neuropsychological functions that they have rated as *important* (score 2) or *very important* (score 1). Panel members were allowed to indicate multiple measures per neuropsychological function, ordered by their perceived relevance (i.e., starting with the most suitable measure). Panel members were further requested to specify the subtest, scale or variable of each measure that would be most suitable to assess the particular neuropsychological function.

Round 2

The second round of the Delphi study aimed to rate the importance of the neuropsychological functions that were additionally suggested by the panel members in the first round. In the beginning of the second round, panel members received an overview of the results obtained by the first round, including the rating of the predetermined list of neuropsychological functions, a list of additional neuropsychological functions that were suggested by panel members during Round 1 as well as an overview of the suggested test measures for the assessment of each of the neuropsychological functions. Subsequently, panel members were presented with 27 functions that were additionally suggested by the expert panel in the first round and were asked to rate the

Table 3. Ratings of the predetermined list of neuropsychological functions according to their relevance for the neuropsychological assessment of adults with ADHD (Round 1).

Function	*N*	Min	Max	*M* ± *SD*	IQR
Sustained attention	27	1	3	1.33 ± 0.56	1
Emotional control	27	1	2	1.59 ± 0.50	1
Distractibility	27	1	3	1.67 ± 0.73	2
Inhibitory control/interference control	26	1	2	1.69 ± 0.68	1
Task planning/organization	27	1	3	1.70 ± 0.72	1
Vigilance	27	1	3	1.70 ± 0.67	1
Working memory	27	1	4	1.74 ± 0.90	1
Self-monitoring	27	1	4	1.96 ± 0.85	2
Focused attention	27	1	4	1.96 ± 0.76	2
Time estimation	27	1	3	2.04 ± 0.65	1
Set shifting/cognitive flexibility	27	1	5	2.15 ± 1.03	2
Task execution	27	1	4	2.22 ± 0.97	1
Processing speed	27	1	5	2.30 ± 0.99	1
Initiation	27	1	4	2.37 ± 0.88	1
Divided attention	27	1	4	2.41 ± 0.84	1
Decision making	27	1	4	2.44 ± 0.75	2
Feedback learning	27	1	5	2.48 ± 0.80	1
Spatial attention	23	1	5	2.70 ± 0.93	1
Problem solving	27	1	4	2.70 ± 0.87	2
Writing	24	1	5	2.71 ± 1.12	1
Short term memory	24	1	5	2.75 ± 1.23	2
Reading	25	1	5	2.84 ± 1.07	1
Verbal fluency	27	1	5	2.89 ± 0.90	1
Reasoning	27	1	5	2.93 ± 0.92	2
Concept formation	27	2	5	2.96 ± 0.85	1
Learning	25	1	5	2.96 ± 1.06	2
Prospective memory	24	1	5	3.00 ± 1.14	1
Visual perception	25	1	5	3.08 ± 1.00	2
Auditory perception	25	1	5	3.08 ± 1.00	2
Long term memory	25	1	5	3.12 ± 1.09	1
Comprehension	25	1	5	3.12 ± 1.24	2
Spatial cognitive functions (e.g., mental rotation)	23	2	5	3.17 ± 0.83	1
Association learning	24	2	5	3.25 ± 0.79	1
Spatial constructive functions	22	2	5	3.27 ± 0.77	1
Recognition	25	2	5	3.28 ± 0.94	1
Expression	25	1	5	3.32 ± 1.07	1
Naming	25	1	5	3.32 ± 0.99	1
Repetition	25	2	5	3.36 ± 0.86	1
Spatial perceptive functions (e.g., face perception)	24	1	5	3.38 ± 0.82	1
Tactile perception	25	2	5	3.40 ± 0.76	1
Autobiographical memory	24	1	5	3.46 ± 0.88	1
Olfactory perception	25	2	5	3.48 ± 0.71	1

Note. Rating ranges from 1 = very important, 2 = important, 3 = neutral, 4 = not important, to 5 = not important at all; IQR = Interquartile range; *N* = Number of panel members rating the function in question.

relevance of each of these functions for the neuropsychological assessment of adults with ADHD on the same 5-point Likert scale as used in the first round. For each of the functions presented, it was additionally indicated how often each function has been suggested by panel members in the first round. After rating the relevance of all 27 functions, panel members were asked to suggest the most suitable measures to assess those functions that they rated as either *important* (score 2) or *very important* (score 1). Analogue to the procedure of the first round, panel members were allowed to indicate multiple measures per function, ordered by their perceived relevance (i.e., starting with the most suitable measure). Panel members were further requested to specify the subtest, scale or variable of each measure that they considered to be most suitable for assessing the particular function.

Round 3

The aim of the third round was to (1) re-evaluate ratings of all neuropsychological functions and to (2) evaluate the measures that were suggested by the expert panel with regard to their suitability for the assessment of particular neuropsychological functions of adults with ADHD. In the beginning of the third round, the expert panel received a list of 46 neuropsychological functions, consisting of the predetermined neuropsychological functions as presented in Round 1 as well as neuropsychological functions that were additionally suggested by the panel members in Round 2. Neuropsychological functions were excluded from further consideration as a potential part of a neuropsychological assessment battery if one of three arguments applied; (1) if the additionally suggested neuropsychological function was already included in the predetermined list of neuropsychological functions, (2) if the additionally suggested neuropsychological function had a large overlap with a function that was already part of the predetermined list (e.g., suggestion to additionally consider *timing*, even though *time estimation* was already part of the predetermined list), and (3) if the additionally suggested function did not qualify as a neuropsychological function, but rather represented a clinical symptom (e.g., hyperactivity/overactivity), coexisting problems (e.g., gambling problems), a concept related to other skills or characteristics (e.g., mathematics or personality), or a more general concept or condition (e.g., psychological state). The functions that were attributed to the third category were not entirely excluded from the present study but were separately presented to the expert panel since these entries were obviously regarded as important concepts for the clinical evaluation of adults with ADHD, even though they do not fall within the scope of a classic neuropsychological assessment.

The list of 46 neuropsychological functions provided two more types of information per function, i.e., the individual rating of the particular panel member himself/herself as well as the average rating of the entire expert panel as derived from the previous rounds. Panel members were requested to reconsider their previous rating for each function in the light of the average group rating. For those neuropsychological functions that were rated by the expert panel in the previous rounds on average as either *important* or *very important*, panel members were asked to rate the suitability of the suggested measures to assess these neuropsychological

functions. Each measure that was suggested by at least two different panel members in the previous rounds was considered for suitability rating. However, in case that only one or two measures had been suggested by the entire expert panel for the assessment of a particular function, these measures were also presented to the expert panel in Round 3, also when they were only suggested by one panel member. The expert panel was asked to indicate for each measure whether they consider it as *suitable* or *not suitable*, or whether they *do not know* the measure. In some cases, when several versions or subtests of a measure have been suggested in Rounds 1 and 2, panel members were asked in Round 3 to first rate the suitability of the general measure, followed by the request to rate the suitability of the specific versions or subtests. These follow-up questions were only presented to those panel members that rated the general measure as *suitable*. Furthermore, panel members were requested to indicate for each measure whether the measure would be part of their assessment battery if they had to compose a neuropsychological assessment of an adult with ADHD in a given situation. Panel members were also given the opportunity to suggest further measures for the assessment of each function.

Finally, panel members were asked to indicate the time they spend on average on a comprehensive neuropsychological assessment of an adult with ADHD as well as the time they would ideally like to have for such an assessment.

Round 4

The aim of the fourth round was to achieve consensus on an assessment battery for the neuropsychological assessment of adults with ADHD. In the beginning of the fourth round, the expert panel was presented with a ranked list of neuropsychological functions as derived from ratings of Round 3. For each function that had an average rating of *important* or *very important* (score < 2.50), two measures were suggested for its assessment. First, the measure that was most frequently rated as *suitable* was presented. Second, the measure with the second highest *suitable* rating and the lowest rate of disapproval (i.e., the fewest *not suitable* ratings) was presented. In addition, descriptive statistics for the average time spent on a comprehensive neuropsychological assessment of an adult with ADHD, and the time panel members would ideally like to spend on such an assessment was presented.

Panel members were further asked whether they agreed with the suggested assessment battery. In case of disagreement, panel members were asked to suggest changes that would lead to their agreement.

Results

Round 1

The ratings of the predetermined neuropsychological functions as well as the additionally suggested functions by the expert panel are presented in Table 3 and 4, respectively. In total, 27 functions were suggested by the panel members in addition to the 42 functions as mentioned on the list of predetermined neuropsychological functions For each neuropsychological function a panel member rated as *important* or *very important*, the panel member was asked to suggest one or more measures to assess this function (see Table S1 of the supplementary information for a complete presentation of all suggested measures for the assessment of the predetermined neuropsychological functions). Interquartile ranges of ratings were determined as an objective measure of consensus between panel members in their evaluation of the importance of each neuropsychological function (Scheibe, Skutsch, & Schofer, 1975). For a Likert-scale with four to five answer options, an interquartile range of 1 or less is considered as a high level of consensus (Raskin, 1994; Rayens & Hahn, 2000). In the ratings of the predetermined list of neuropsychological functions of Round 1, high consensus, as indicated by interquartile ranges of 0 or 1, was achieved for 30 of the 42 neuropsychological functions.

Round 2

In the second round of the study all functions that were additionally suggested by the expert panel in the first round were rated regarding their importance for the neuropsychological assessment of adults with ADHD (see Table 4). The level of consensus among panel members on their ratings was again addressed by interquartile ranges. This calculation revealed consensus (i.e., interquartile range of 0 or 1) for 17 of the 27 suggested functions. Furthermore, panel members suggested measures to assess those functions that they rated as *important* or *very important* (see Table S2 of the supplementary information for a complete presentation of all measures that were suggested for the assessment of the additional functions).

Round 3

Round 3 of the study resulted in a final ranking of 46 neuropsychological functions as derived from a re-evaluation of the ratings of all neuropsychological functions from Round 1 and 2 (Table 5). This final ranking of neuropsychological functions contained both functions from the predetermined list of

Table 4. Ratings of functions that were additionally suggested by panel members for the neuropsychological assessment of adults with ADHD (Round 2).

Function	*N*	Min	Max	*M* ± *SD*	IQR
Impulsivity	20	1	2	1.20 ± 1.20	0
Hyperactivity/Overactivity	19	1	2	1.21 ± 0.42	0
Attentional control	20	1	3	1.50 ± 0.61	1
Psychological state	19	1	4	1.53 ± 0.84	1
Emotional lability	20	1	3	1.60 ± 0.68	1
Sustained attentional effort	19	1	3	1.63 ± 0.60	1
Low frustration tolerance	20	1	4	1.70 ± 0.92	2
Motivation	20	1	4	1.70 ± 0.87	1
Response variability/Inconsistency	19	1	4	1.74 ± 0.93	2
Social functioning	20	1	3	1.75 ± 0.79	2
Presence of learning disability	19	1	3	1.79 ± 0.79	1
Mind wandering	19	1	3	1.84 ± 0.77	1
Malingering	19	1	4	1.89 ± 0.99	2
Motor inhibition	19	1	3	1.95 ± 0.62	1
Delay aversion	19	1	4	2.00 ± 0.75	0
Reward processing	18	1	4	2.11 ± 0.83	2
State regulation	19	1	3	2.11 ± 0.74	2
Personality	19	1	4	2.21 ± 1.30	2
Multitasking	20	1	4	2.25 ± 0.97	1
Intelligence	19	1	5	2.26 ± 1.15	2
Visual attentional processing	20	1	5	2.45 ± 1.05	1
Ability to synthesize	19	1	4	2.58 ± 0.90	1
Presence of gambling problems	19	1	4	2.63 ± 0.96	2
Audio vs. visual processing speed	19	1	5	2.68 ± 0.95	1
Mathematics	18	1	5	3.11 ± 0.96	2
Figural fluency	19	1	4	3.11 ± 0.94	1
Allocentric visual memory	19	2	5	3.32 ± 0.95	1

Note. Rating ranges from 1 = very important, 2 = important, 3 = neutral, 4 = not important, to 5 = not important at all; IQR = Interquartile range; *N* = Number of panel members rating the function in question.

neuropsychological functions, as well as functions that were additionally suggested by panel members in the previous rounds. Consensus among members of the expert panel was high across all neuropsychological functions in the final ranking as indicated by an interquartile range of 0 or 1 for the ratings of all functions (Raskin, 1994; Rayens & Hahn, 2000). As described above (see *materials and procedure* section), not all functions that were additionally suggested by the expert panel were considered in the final rating of neuropsychological functions in order to avoid redundancy and to restrict the list to typical neuropsychological functions. Functions that were suggested by the expert panel but that do not fall within the narrower focus of neuropsychology were listed separately as they are perceived by the panel members as important concepts within the clinical evaluation of adults with ADHD (Table 6).

Moreover, an assessment battery was composed for the examination of those functions that received an average rating score of 2.5 or lower (i.e., *important* or *very important*). This battery suggests the measure that was rated most often as *suitable* by the expert panel for each neuropsychological function. As an 'alternative measure', the battery suggests the measure that was rated second most often as *suitable* for each individual neuropsychological function, while having the lowest rate of *not suitable* ratings (see Table 7 for a complete presentation of the assessment battery). Alternative measures could not be suggested for all neuropsychological functions of the assessment battery. This was the case if either no alternative measure was suggested by panel members, or the suggested measure was considered *not suitable* by at least one third of all panel members who indicated to know the measure. The information obtained from the question whether the measure at hand would be part of the assessment battery if the panel member had to perform an individual

Table 5. Final ratings of all neuropsychological functions for the neuropsychological assessment of adults with ADHD (Round 3).

Rank	Function	*N*	Min	Max	*M* ± *SD*	IQR
1	Sustained attention	22	1	3	1.36 ± 0.58	1
2	Distractibility	22	1	3	1.36 ± 0.58	1
3	Inhibitory control/Interference control	22	1	3	1.55 ± 0.60	1
4	Task planning /Organization	22	1	3	1.59 ± 0.67	1
5	Working memory	22	1	4	1.82 ± 0.80	1
6	Self-monitoring	22	1	4	1.82 ± 0.73	1
7	Motor inhibition	22	1	3	1.91 ± 0.53	0
8	Focused attention	22	1	4	1.91 ± 0.75	1
9	Malingering/Motivation	22	1	5	1.95 ± 0.95	1
10	Task execution	22	1	3	2.05 ± 0.72	1
11	Time estimation	22	1	3	2.09 ± 0.61	0
12	Processing speed	22	1	4	2.23 ± 0.75	1
13	Set shifting/Cognitive flexibility	22	1	4	2.27 ± 0.83	1
14	Reward processing	22	2	4	2.32 ± 0.65	0
15	Initiation	22	1	4	2.32 ± 0.78	1
16	Decision making	22	1	4	2.45 ± 0.67	1
17	Divided attention	22	2	4	2.55 ± 0.60	1
18	Short term memory	22	1	4	2.59 ± 0.85	1
19	Visual attentional processing	22	1	5	2.73 ± 0.94	1
20	Feedback learning	22	1	5	2.73 ± 0.83	1
21	Spatial attention	22	1	4	2.73 ± 0.63	1
22	Problem solving	22	1	4	2.73 ± 0.83	1
23	Ability to synthesize	22	1	4	2.77 ± 0.81	1
24	Audio vs. visual processing speed	22	1	4	2.82 ± 0.73	1
25	Verbal fluency	22	1	5	2.86 ± 0.99	1
26	Learning	22	1	4	2.91 ± 0.81	1
27	Long term memory	22	1	5	3.00 ± 0.87	0
28	Comprehension	22	1	5	3.05 ± 0.90	0
29	Reasoning	22	1	5	3.05 ± 0.90	1
30	Prospective memory	22	2	5	3.05 ± 0.84	0
31	Concept formation	22	1	5	3.18 ± 0.91	1
32	Spatial cognitive functions	22	2	5	3.18 ± 0.80	0
33	Auditory perception	22	2	5	3.23 ± 0.75	0
34	Visual perception	22	2	5	3.27 ± 0.77	1
35	Figural fluency	22	2	5	3.32 ± 0.89	1
36	Association learning	22	2	5	3.41 ± 0.85	1
37	Expression	22	1	5	3.55 ± 0.96	1
38	Naming	22	2	5	3.55 ± 0.86	1
39	Repetition	22	2	5	3.59 ± 0.85	1
40	Spatial constructive functions	22	3	5	3.64 ± 0.79	1
41	Recognition	22	2	5	3.64 ± 0.85	1
42	Autobiographical memory	22	1	5	3.68 ± 0.95	1
43	Allocentric visual memory	22	3	5	3.73 ± 0.83	1
44	Spatial perceptive functions	22	3	5	3.77 ± 0.75	1
45	Olfactory perception	22	3	5	3.82 ± 0.66	1
46	Tactile perception	22	2	5	3.82 ± 0.73	1

Note. Rating ranges from 1 = very important, 2 = important, 3 = neutral, 4 = not important, to 5 = not important at all; IQR = Interquartile range; *N* = Number of panel members rating the function in question.

Table 6. Ratings of functions that were suggested for the clinical evaluation of adults with ADHD that do not fall within the scope of a neuropsychological assessment (Round 2).

Function	*N*	Min	Max	*M* ± *SD*	IQR	Reason for exclusion[a]
Impulsivity	20	1	2	1.20 ± 1.20	0	a
Hyperactivity/ Overactivity	19	1	2	1.21 ± 0.42	0	a
Psychological state	19	1	4	1.53 ± 0.84	1	d
Emotional control[b]	27	1	2	1.59 ± 0.50	1	c
Emotional lability	20	1	3	1.60 ± 0.68	1	a
Low frustration tolerance	20	1	4	1.70 ± 0.92	2	a
Social functioning	20	1	3	1.75 ± 0.79	2	c
Presence of learning disability	19	1	3	1.79 ± 0.79	1	b
Mind wandering	19	1	3	1.84 ± 0.77	1	a
Delay aversion	19	1	4	2.00 ± 0.75	0	a
State regulation	19	1	3	2.11 ± 0.74	2	d
Personality	19	1	4	2.21 ± 1.30	2	c
Multitasking	20	1	4	2.25 ± 0.97	1	c
Intelligence	19	1	5	2.26 ± 1.15	2	c
Presence of gambling problems	19	1	4	2.63 ± 0.96	2	b
Mathematics	18	1	5	3.11 ± 0.96	2	c

Note. Ratings range from 1 = very important, 2 = important, 3 = neutral, 4 = not important, to 5 = not important at all; IQR = Interquartile range; *N* = Number of panel members rating the function in question. [a]Reasons for exclusion: (a) clinical symptoms, (b) coexisting problems, (c) concepts related to other skills or characteristics, (d) general concept or condition. [b]Rating was based on results from Round 1 due to an administration error in Round 2.

neuropsychological assessment of an adult with ADHD, was not considered for the final ranking. The reason was that when panel members answered this question, they primarily considered those measures that are available in their own work context instead of the general usefulness of the measures suggested. Moreover, responses to this question did not take the utility of other measures that may be equally, or even more suitable than the one they use in their daily work, into account. Thus, we considered the suitability rating, that allowed panel members to indicate several suitable measures as well as measures that are unknown to the panel members, as more informative for a valid ranking of neuropsychological measures.

Finally, panel members were requested to indicate the time they spend on average on a comprehensive neuropsychological assessment of adults with ADHD as well as the time they ideally like to spend on such an assessment. As presented in Table 8, the median time panel members spend on average on a neuropsychological assessment of adults with ADHD is 2 h 15 min (median absolute deviation 1 h 15 min). The median time panel members ideally like to spend on a neuropsychological assessment of adults with ADHD, however, is 3 h (median absolute deviation 1 h 15 min).

Round 4

Fifteen (71.4%) of the 21 panel members that participated in the fourth round agreed with the assessment battery without further changes, five panel members (23.8%) disagreed with the assessment battery in such

Table 7. Test battery for the neuropsychological assessment of adults with ADHD as suggested by the expert panel.

Rank	Neuropsychological function	Mean rating	Most suitable measure[a]	Suitable[b] (%)	Not suitable[c] (%)	Alternative measure[d]	Suitable[b] (%)	Not suitable[c] (%)
1	Sustained attention	1.36	CPT (1. TOVA, 2. CPT III)	91	5	TAP	50	0
2	Distractibility	1.36	CPT (1. CPT III, 2. IVA + PLUS)	73	18	TAP	59	14
3	Inhibitory control/Interference control	1.55	GNG	86	5	Stop signal task	82	5
4	Task planning/Organization	1.59	BRIEF	64	18			
5	Working memory	1.82	Digit Span test	81	18	TAP	46	0
6	Self-monitoring	1.82	Self-report	64	14			
7	Motor inhibition	1.91	Stop signal task	18	0			
8	Focused attention	1.91	CPT (TOVA/CPT III)	73	18	TAP (1. GNG, 2. Alertness)	50	9
9	Malingering/Motivation	1.95	TOMM	55	14	Reliable Digit Span	36	9
10	Task execution	2.05	Self-report	50	14			
11	Time estimation	2.09	Temporal estimation	55	9			
12	Processing speed	2.23	Digit symbol substitution test	91	5	WAIS	91	9
13	Set shifting/Cognitive flexibility	2.27	TMT	82	14	WCST	73	18
14	Reward processing	2.32	Iowa Gambling task	55	14			
15	Initiation	2.32	Self-report	55	5	DKEFS	41	9
16	Decision making	2.45	Self-report	68	14	Gambling tests	55	18

Note. Rating ranges from 1 = very important, 2 = important, 3 = neutral, 4 = not important, to 5 = not important at all; CPT: Continuous Performance Test; TOVA: Test of Variables of Attention; CPT III: Conners Continuous Performance Test 3rd Edition; TAP: Tests of Attentional Performance; IVA + Plus: Integrated Visual and Auditory Continuous Performance Test; GNG: Go/No Go test; BRIEF: Behavior Rating Inventory of Executive Function; TOMM: Test of Memory Malingering; WAIS: Wechsler Adult Intelligence Scale; TMT: Trail Making Test; WCST: Wisconsin Card Sorting Test; DKEFS: Delis-Kaplan Executive Function System. [a]Shows the measure with the highest percentage of suitability ratings. [b]% of participants that rated measure as suitable. [c]% of participants that rated measure as not suitable. [d]Shows the measure with the second highest suitability rating and the lowest percentage of disapproval.

Table 8. Duration of a comprehensive neuropsychological assessment of adults with ADHD according to panel members.

	25th percentile	Median	75th percentile	Median absolute deviation
Actual time[a]	1 h 8 min	2 h 15 min	4 h 45 min	1 h 15 min
Desired time[b]	1 h 30 min	3 h	4 h	1 h 15 min

Note. [a]Time spent on average on a comprehensive neuropsychological assessment of adults with ADHD. [b]Desired time to spend on a comprehensive neuropsychological assessment of adults with ADHD.

a way that they suggested further changes, and one panel member (4.8%) generally disagreed with the approach. More specifically, the five panel members disagreed with the battery in specific details, that is the lack of consideration of other functions or measures (three panel members), the length of the battery (one panel member), or an overlap between functions and/or measures as contained in the battery (one panel member).

Discussion

Based on the knowledge and expertise of an international panel of experts in the field of adult ADHD, the present study derived a ranking of neuropsychological functions with regard to their importance for the neuropsychological assessment of adults with ADHD. A high level of consensus was attained in the evaluation of neuropsychological functions as indicated by interquartile ranges of 0 or 1 for all functions, which is considered as an objective and rigorous measure of group consensus (Scheibe et al., 1975). The ratings revealed that 16 neuropsychological functions were considered by the panel members to be important for the neuropsychological assessment of adults with ADHD. On this basis, a neuropsychological assessment battery was composed. The majority of the panel members (71.4%) agreed with the assessment battery without further changes. Five experts (23.8%) disagreed only in a specific aspect, while only one panel member (4.8%) generally disagreed with the approach. Given that the assessment battery contains measures that are commonly used in research and clinical practice, it may have the potential to give both clinicians and researchers a toolkit for the selection of widely accepted measures for the neuropsychological assessment of adults with ADHD. In this context, it must be stressed that the assessment battery is not meant to serve as a diagnostic tool to diagnose ADHD in adults, but provides a selection of functions and measures for the cognitive assessment of adults that are *already diagnosed* with ADHD. Such a battery is useful to characterize neuropsychological strengths and weaknesses and offer specific information for individualized treatment planning (Lange et al., 2014). For example, a clinical neuropsychological assessment can increase awareness of patients and relatives about individual strengths and weaknesses and can be used to design and implement individual compensation strategies, e.g., using external memory aids, decreasing environmental distraction, using personal organizers, or developing daily routines. In addition to support treatment planning, a neuropsychological assessment can be useful to objectify subjectively reported complaints and thus increase individual compliance and adherence to treatment. By suggesting an alternative measure in addition to the most suitable measure for the assessment of the majority of neuropsychological functions, the compiled battery takes the availability of measures across different institutes into account, as well as the differences in priorities when selecting functions and measures for the assessment of individual patients. Thus, by providing a complete ranking of all neuropsychological functions discussed, as well as the suggestion of two measures for most of the relevant functions (best suited and alternative measure), the suggested assessment battery can be flexibly adapted based on individual needs of clinicians and researchers (e.g., by selecting specific functions and/or measures only). The use of the suggested assessment battery may also depend on the time that is available for an assessment. The present study revealed that there is considerable variation across experts in the field with regard to the time spent on neuropsychological assessment of adults with ADHD. The present findings also indicate that thorough neuropsychological assessment is considered relevant as additional test time is desired by the panel members. Furthermore, it was shown that panel members wish to perform neuropsychological assessments of adults with ADHD more elaborately than they are currently able to perform in their given context.

Of note, the functions that were rated by the expert panel as being of importance for the neuropsychological assessment of adults with ADHD largely correspond to the results of empirical research that identified robust impairments in several aspects of cognition in adults with ADHD as reported in reviews, meta-analyses, and studies using comprehensive neuropsychological test batteries (Alderson et al., 2013; Boonstra et al., 2005; Fuermaier et al., 2015; Hervey et al., 2004; Mostert et al., 2015; Schoechlin & Engel, 2005; Woods et al., 2002). Nevertheless, ratings of experts and results of previous empirical research did not overlap in all components, as for example verbal memory and fluency functions have repeatedly been shown to be compromised in adults with ADHD (Fuermaier et al., 2015; Fuermaier et al., 2016; Skodzik, Holling, & Pedersen,

2017; L. Tucha et al., 2011; O. Tucha et al., 2005), but were not rated by the expert panel of the present study for inclusion in the assessment battery. As a possible explanation for this discrepancy, it must be considered that memory problems in adults with ADHD were described to arise particularly in those memory functions that are strongly associated with executive control (Fuermaier, Tucha, Koerts, Aschenbrenner, Westermann, et al., 2013; Muir-Broaddus et al., 2002; Pollak et al., 2008). Thus, it can be speculated that panel members assume that memory problems of adults with ADHD occur secondary to executive dysfunctions, and therefore did not prioritize the assessment of memory in the neuropsychological assessment of adults with ADHD. Concerning fluency functions, it can be speculated that panel members did not assign this function a high rank as test performance in fluency functions might clinically be more difficult to interpret with regard to its implications for daily life functioning compared to neuropsychological functions with more obvious associations to tasks of daily living, such as distractibility or task planning. In contrast, the expert panel considered also functions as important which did not play a central role in the majority of research on the clinical neuropsychology of adults with ADHD, such as time estimation. There is indeed evidence of altered time estimation and reproduction in individuals with ADHD (Barkley, Edwards, Laneri, Fletcher, & Metevia, 2001; Mette et al., 2015; Noreika, Falter, & Rubia, 2013; Pollak, Kroyzer, Yakir, & Friedler, 2009; Prevatt, Proctor, Baker, Garrett, & Yelland, 2011), nevertheless, measures of time estimation and reproduction have not been routinely used in the assessment of adults with ADHD. Taken together, our conclusion is twofold. While the results of the present study are consistent with major findings of empirical neuropsychological research of the last decades, they also shed light on the topic from a more clinical perspective. This perspective weights the importance of individual neuropsychological functions in the assessment of adults with ADHD differently than they have been treated in previous research (e.g., fluency functions or time estimation).

With regard to the measures of the composed assessment battery, it was noted that the expert panel selected several computerized tests for one or more aspects of attention, such as variants of the *Continuous Performance Test* (CPT) or subtests of the *Test battery of Attention Performance* (TAP). The CPT and TAP are indeed prominent and widely used tests in the clinical assessment of children and adults with ADHD (Epstein, Conners, Sitarenios, & Erhardt, 1998; Epstein et al., 2001; Fuermaier et al., 2015; Huang-Pollock, Karalunas, Tam, & Moore, 2012; Marchetta, Hurks, De Sonneville, Krabbendam, & Jolles 2008, O. Tucha, Mecklinger, et al., 2006; O. Tucha, Walitza, et al., 2006); however, their clinical use have also been criticized for a number of reasons (Berger, Slobodin, & Cassuto, 2017; Hall et al., 2016). For example, diagnostic precision of CPTs (and related tests for attention) to determine ADHD was mostly inaccurate. While sensitivity towards ADHD was shown to be reasonable in several studies, specificity towards normal controls and individuals with other psychiatric disorders was often low (Arble, Kuentzel, & Barnett, 2014; Edwards et al., 2007; Forbes, 1998; Park et al., 2016; Riccio & Reynolds, 2001; Schatz, Ballantyne, & Trauner, 2001). Thus, CPT test failure is not disorder specific, as there are usually multiple possible reasons why someone would show poor performance on a CPT. Furthermore, only moderate correlations were found between CPT performance and parent or teacher ratings of individuals with ADHD (Forbes, 1998; Rielly, Cunningham, Richards, Elbard, & Mahoney, 1999), which is related to the critique of low ecological validity of CPTs (i.e., inability to simulate difficulties of patients in everyday life). Several authors stressed the need to improve the ecological validity by assessing the individual's behavior in more natural settings, because most CPTs do not contain external and environmental distracting stimuli (Negut, Jurma, & David, 2016; Parsons, Bowerly, Buckwalter, & Rizzo, 2007). As another concern about CPTs, test-retest reliability varied considerably across studies and CPT measures used. In general, omission errors tended to have lower reliability, while commission errors and reaction time variables had higher reliability (Berger & Cassuto, 2014; Ogundele, Ayyash, & Banerjee, 2011). If the CPT does not prove to fulfill sufficient requirements on reliability, it may also not be appropriate for monitoring treatment effects. Further critiques on the CPT concerned that developmental changes in ADHD symptomatology were not consistently reflected in changes in CPT performance (Vaughn et al., 2011), and that many current versions of CPTs have ceiling effects, which appeared to be associated to the simplicity of CPTs including visual stimuli (Berlin, Bohlin, Nyberg, & Janols, 2004, Mahone, Pillion, & Hiemenz, 2001). Because of these serious limitations associated to the CPT, multiple expert groups concluded in consensus statements and clinical practice guidelines that computerized testing of sustained attention, such as with variants of the CPT, is not useful for clinical diagnosing of ADHD (American Academy of Pediatrics, 2001; Gualtieri & Johnson, 2011; Seixas, Weiss, & Muller, 2012; Wolraich et al., 2011).

Representativeness of the expert panel

One of the most important determinants of success of a Delphi study is the qualification of the panel members as experts in the field (Hasson, Keeney, & McKenna, 2000). Several characteristics of panel members of the present study give a good indication that they indeed constitute a group with high expertise in the field of adult ADHD. First, the academic degree/position of the expert panel was high, with most panel members being professors and/or having a doctor title. Second, the number of publications in the field of neuropsychological functioning of adults with ADHD was high and considerably exceeded the minimum inclusion criterion of two publications per panel member (see Table 2). Other characteristics of an expert panel that may distort data analysis and interpretation are panel size, response rate, response bias and drop-out bias. It has been argued that for homogeneous panels a group size of 10–15 members is in most cases sufficient (Delbecq, Van de Ven, & Gustafson, 1975). The expert panel of the present study (20–27 members) exceeded this number, leading to the conclusion that panel size was adequate. Regarding the response rate, it was noted that 64 potential candidates opened the questionnaire and started to fill in information, whereas only 27 panel members actually completed the first round. Nonetheless, more than 70% of panel members remained part of the expert panel throughout the Delphi process (27 panel members in the first round to 21 panel members in the fourth round), which has been noted by several authors to be necessary to achieve a rigor Delphi process (e.g., Sumsion, 1998; Walker & Selfe, 1996). Conclusions regarding a response bias are difficult to draw as it remains unknown why some invited experts agreed to participate in the study while others did not. However, considering the acceptable sample size and the high expertise of the panel members, it may be assumed that the expert panel forms a representative group of experts in the field of clinical neuropsychology of adult ADHD. Finally, conclusions regarding a bias due to drop out can be drawn when comparing panel characteristics of the different rounds. While many characteristics were comparable across panel members of the different rounds, such as age, geographic location, academic background, or type of work, other characteristics differed considerably between panels of the four rounds, such as gender distribution or the number of publications. Most obviously, the mean number of publications dropped from about 21 publications in the first round to about 9 publications in the second round, and rose back to a level comparable to the first round in Rounds 3 and 4. While it cannot be excluded that a response bias might have occurred due to these differences in panel characteristics, distortions of the Delphi process might have been little given that this bias was caused by a very high number of publications of single panel members, and given that all information that was contained in round 2 (evaluation of functions that were additionally suggested by panel members) was evaluated by the panel in Round 3.

Limitations

The present study must be seen in the context of limitations. First, not all panel members agreed with the assessment battery as presented in Round 4. More specifically, six panel members disagreed with the approach because of specific reasons (five panel members) or general disagreement (one panel member). However, it can be argued that the specific aspects of the assessment battery to which panel members disagreed might not be a major threat to the study in most cases. For example, disagreement with specific functions, measures, or the total length of the battery (four panel members) could be compensated by considering the suggested battery as a toolkit that does not need to be performed in its entire length in all cases, but instead can be applied in parts only in order to accommodate the respective situation in the individual clinical setting. In contrast, the critique of a large overlap between functions and measures (one panel member) is a valid point that must be considered when interpreting the use of the present assessment battery, as evidently some of the measures assess more than one function (e.g., panel members suggested the CPT for the assessment of sustained attention, distractibility, and focused attention). We regret that it was not possible to take this rather complex issue into account when composing the battery. Considering the already substantial time investment of panel members over four rounds of the Delphi process, additional time investment of panel members was not requested in order to avoid a large drop-out rate.

Furthermore, the present study failed to suggest an alternative measure for the assessment of each function of the assessment battery as an acceptable suitability rating was not achieved for an alternative measure of all functions (for about one third of functions, no alternative measure could be provided). Given the differences in availability and preferences of clinical tools across institutes, an alternative measure for the assessment of each aspect of functioning would certainly be an advantage.

Finally, further limitations occurred that are associated with the Delphi methodology. For example, the guided process towards group consensus may eliminate divergent but potentially important opinions of single panel members. Thus, the results of a Delphi study represent the solutions with largest overlap between panel members, but do not necessarily represent optimal solutions or objective truth on a specific topic. Therefore, the results should rather be seen as the compromise on the design of a neuropsychological assessment of adults with ADHD as it is applied by an international panel of experts in research and clinic. Moreover, the characteristics of a Delphi process do not allow direct communication and discussion between panel members. In the present context, the selection of tests, subtests, or variables of specific measures might have been facilitated by personal discussion between panel members. However, personal communication was not allowed in order to ensure crucial characteristics of a Delphi process, such as the avoidance of group pressure toward conformity and the influence of authority.

Conclusion

The present study employed a Delphi methodology to perform a ranking of 46 neuropsychological functions regarding their importance for the neuropsychological assessment of adults with ADHD. This process led to the composition of a test battery suggesting measures for the assessment of 16 functions that were rated as either important or very important. This study was the first of its kind among experts in the field of ADHD and provides a toolkit of functions and measures that can be used for an objective assessment of cognitive functions of adults with ADHD. While it must be emphasized that a neuropsychological assessment is neither sensitive nor specific enough to diagnose ADHD, a neuropsychological assessment is very useful to complement diagnostic assessment and serves as an objective indication of cognitive dysfunctioning of individuals diagnosed with ADHD. Results of such a clinical neuropsychological assessment can increase awareness of individual strengths and weaknesses and can be used to design and implement compensation strategies. Furthermore it can be useful to objectify subjectively reported complaints and thus to increase individual compliance and adherence to treatment. The observed differences between the results of the present Delphi study and previous neuropsychological research on adults with ADHD underline the importance of the Delphi methodology and highlight the clinical relevance of the present results.

Disclosure of interest

The authors report no conflicts of interest.

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